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Index terms:
Kidney, interventional procedures, 81.1263
Ureter, stenosis or obstruction, 82.843, 82.844
Ureter, stents, 82.1269

Published online before print 10.1148/radiol.2302030078
Radiology 2004; 230:435–442

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Ureteral Stent Placement without Postprocedural Nephrostomy Tube: Experience in 41 Patients[1]

PURPOSE: To evaluate one-stage antegrade ureteral stent placement without postprocedural nephrostomy tube.

MATERIALS AND METHODS: Tubeless ureteral stent insertion was attempted in 41 (30 men, 11 women; eight, benign obstruction; nine outpatients) of 97 adults (56 excluded). Patients were clinically stable with known ureteral obstruction and had been referred for antegrade ureteral stent insertion. Exclusion criteria were infection, coagulopathy, or emergency cases. After renal access was achieved, ureteral stents were inserted. If drainage was satisfactory and there was no marked procedural bleeding, all access was removed without leaving a nephrostomy tube behind. Technical and clinical success rates and complications were assessed with review of radiologic and clinical notes. If one-stage stent insertion was unsuccessful, a nephrostomy tube was inserted and two-stage stent placement was performed. All 56 patients excluded from this study underwent two-stage stent placement. Major complication rate was assessed (Fisher test).

RESULTS: One-stage stent insertion was technically successful in 36 (88%) patients; two with an identifiable risk factor (recent bladder operation, retrograde ureteral instrumentation) developed septicemia that required repeat nephrostomy tube insertion and 2–8 extra days of hospitalization. Clinical success rate was 83% (34 of 41). No major bleeding occurred. In 13 (36%) of 36 patients, hematuria lasted longer than 24 hours but resolved without further intervention or blood transfusion. In those who underwent two-stage stent placement ($n = 61$), technical success rate was 100%, but clinical success rate was 98%; one patient developed septicemia, and no major hemorrhage occurred. Difference in major complication rate between groups was not significant (6% [two of 36] vs 2% [one of 61]; $P = .55$).

CONCLUSION: One-stage tubeless antegrade ureteral stent insertion in selected cases showed 88% technical success rate and 83% clinical success rate, with no major hemorrhage.

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Increasing attention has focused on improving the acceptability and morbidity of antegrade renal and urologic procedures. The value and safety of outpatient nephrostomy in adults and children has been explored in three separate studies (1–3); in two (2,3), researchers reported favorable results as long as the patients were carefully selected. Separately, a number of refinements of percutaneous nephrolithotomy have addressed the issue of the tube-related morbidity after surgery (4). For such surgery, a large track (30 F) is created for the percutaneous working sheath and stone removal. After the procedure, the track is exchanged for a 24–30-F percutaneous tube—a nephrostomy catheter—to ensure satisfactory renal drainage and to tamponade the track. Because of the size and rigidity of the nephrostomy tube, postoperative pain control can be a problem. Some workers have attempted to minimize this tube-related morbidity and advocate tubeless percutaneous nephrolithotomy (5–7); they report that in many cases the protective nephrostomy tube is unnecessary, and the sheath could be removed after the procedure if satisfactory ureteral drainage was assured and bleeding was only minimal.

For antegrade ureteral stent insertion, attention has focused on shortening the duration of the procedure. Traditionally this was a two-stage procedure. After relief of ureteral obstruction with a nephrostomy catheter (8–10) and a few days of satisfactory external drainage, an antegrade stent was inserted in a second procedure. Thus, an individual stent insertion episode may last 2–5 days in total. This two-stage procedure or secondary ureteral stent placement is being increasingly superseded by primary antegrade stent placement. In primary antegrade stent placement, primary renal access and stent insertion are performed as a single procedure, and this single procedure has an 80% reported success rate (11). As originally described (11), even this procedure required a covering nephrostomy catheter to guard against poor stent function and was removed after 12–24 hours of satisfactory ureteral drainage. From the patient's perspective, an antegrade ureteral stent procedure was still relatively prolonged—a stent was inserted on day 1 with a nephrostomy tube left in situ, and the covering nephrostomy tube was removed on day 2; the patient either stayed in the hospital overnight or required two outpatient visits to the interventional radiology department. However, if the encouraging experience of tubeless percutaneous nephrolithotomy could be extended to the antegrade ureteral stent procedure, the latter promises to be a true one-stage or tubeless stent service, and the patient would visit the interventional suite only once. The attraction of such a one-stage procedure is obvious, but advantages may be outweighed if they are accompanied by an increased risk to the patient or a higher complication—in particular increased bleeding or septicemia—rate.

The purpose of our study was to evaluate the technical success and complications of one-stage antegrade ureteral stent placement.

MATERIALS AND METHODS

Patients

Patients had been referred by the urology or oncology service for relief of ureteral obstruction by means of antegrade ureteral stent placement. Most patients had been referred for antegrade stent placement as a first option because of anticipated difficulty with the retrograde route (eg, patients with a large-volume bladder tumor or an extensive locally invasive prostate or a pelvic malignancy). Others had undergone retrograde stent insertion that failed. For a retrospective study, our institution does not require formal institutional review board approval or informed consent. However, informed consent for the procedure was obtained from each patient after a discussion about the indications, advantages, and risks of removal of all external access at the end of the procedure. A patient information sheet was also provided with details, methods, and side effects of the procedure.

Patient Selection Criteria

All patients selected by the senior author (U.P.) during the study period (September 1997 to December 2000) were assessed for suitability of undergoing one-stage stent placement. The inclusion criteria were as follows: The patients were adults who were older than 18 years. They had to have a known or established cause of unilateral or bilateral ureteral obstruction. They had to be referred for relief of ureteral obstruction with antegrade ureteral stent placement. They had to have normal results of preprocedural hematologic studies according to our department protocol, and these included a hemoglobin level of greater than 10 g/dL (100 g/L), a platelet count of greater than $80{,}000 \times 10^9$/L, and normal clotting function (prothrombin time < 3 seconds above laboratory control values or international normalized ratio < 1.3). (The underlying cause or severity of the obstruction was not an eligibility or exclusion criterion.)

Exclusion criteria were as follows: coagulopathy, even if the hematologic abnormality had been corrected by the time of stent insertion; known or suspected urosepsis (temperature, >38°C; white blood cell count, elevated; urine or blood cultures, positive for bacteria); hemodynamic instability (systolic blood pressure of <100 mm Hg and/or pulse rate of >100 beats per minute); emergency cases; regular aspirin or antiplatelet therapy.

Forty-one of 97 patients fulfilled the selection criteria, and their mean age was 56 years, with an age range of 21–76 years. The mean age of the 56 excluded patients was 59 years, with an age range of 28–77 years.

Preprocedural Care

Antibiotics were administered intravenously according to our standard hospital policy. This policy specifies that gentamicin sulfate (Cidomycin; Hoechst Marion Roussel, West Malling, England), or a broad-spectrum cephalosporin (cefotaxime sodium, Claforan; Aventis Pharma, West Malling, England) if gentamicin is contraindicated, is to be administered for all percutaneous or endoscopic urologic interventions. Standard intravenous administration of sedatives and analgesics, midazolam hydrochloride (Hypnovel; Roche, Welwyn Garden City, England) and/or pethidine (Auden Mckenzie Martindale, Wembley, England), was performed. Doses were titrated on a per-patient basis, and usually 2.5–10.0 mg of midazolam and 25–100 mg of pethidine were used. Oxygen saturation and pulse rate were measured continuously with pulse oximetry, and blood pressure was measured every 5 minutes or more often.

Method

A standard method was used in all cases. Initial entry was gained into the renal collecting system with ultrasonographic (ATL HDI 1000; ATL Laboratories, Bothell, Wash) guidance and a fine 22-gauge 13.97-cm-long Chiba needle (Becton Dickinson, Franklin Lakes, NJ). Controlled aliquots of iodinated contrast medium (iodixanol 320, Visipaque; Nycomed Amersham, Little Chalfont, England) and carbon dioxide were then injected to obtain a double-contrast pyelogram. Ideally, a lower-pole calyx, facing posteriorly, was then selected for secure renal entry. If a lower-pole calyx was unsuitable—for example, because of overlying ribs or acuteness of the lower-pole infundibulum or pelvic angle—then an upper-pole or interpolar (middle-pole) calyx was punctured. Definitive renal entry was made into the chosen calyx with fluoroscopic guidance by using an 18-gauge needle with a 5-F sheath (Leigen needle set; Angiomed, Karlsruhe, Germany). Considerable care was taken about definitive renal entry. To minimize vascular trauma, repeated angulation of the fluoroscopic C-arm was used to ensure entry into either the fornix or the papillary tip of the calyx. After calyceal entry was confirmed by means of aspiration of urine, a stiff 0.035-inch-diameter floppy-tipped guide wire (Amplatz stiff wire, William Cook Europe, Bjaeverskov, Denmark) was manipulated well into the renal pelvis.

Next, the sheath and stiff guide wire were exchanged for a 6.5-F angled-tip catheter (Torcon Blue BMC; William Cook Europe) and a curved-tip 0.035-inch hydrophilic wire (Terumo Europe,

Leuven, Belgium). With wire and catheter manipulation, entry was gained into the ureter, and passage of the ureteral stricture was attempted. If successful, the hydrophilic wire and catheter were advanced into the bladder, exchanged for a floppy-tipped 0.035-inch stiff guide wire (Amplatz Super Stiff wire; Boston Scientific, Watertown, Mass), and a double-pigtail ureteral stent was inserted. In all cases, an 8-F stent (Meditech; Boston Scientific) was used—the stent pusher of this device has a clear radiopaque marker. The length of stent chosen depended on the patient's height (12). Other pieces of equipment were used as necessary: A 9-F sheath (Banana Peel; Boston Scientific) was used when the ureter was very tortuous, and a 9-F dilation catheter was used when the tightness of the stricture required predilation prior to stent insertion, with additional balloon dilation by using a 6-mm-diameter 4-cm-long balloon dilation catheter (BlueMax; Boston Scientific), if necessary. Finally, if the stricture could not be bypassed with the 6.5-F angled-tip catheter, a 4-F hydrophilic catheter (Cobra 2 Glidecath; Terumo Europe) was used first, and then afterward a 9-F dilation catheter (van Andel Dilation Catheter; William Cook Europe) was used.

In all cases of successful stent placement, a nephrostogram was obtained immediately to assess stent function and document the amount of clotting in the renal pelvis. For this assessment, the 6.5-F angled-tip catheter was reintroduced into the renal pelvis, and iodinated contrast material (iodixanol 320) was slowly injected, with the fluoroscopic table tilted feet down to aid drainage. To minimize the risk of intravasation and systemic bacteremia, care was taken not to overdistend the system. The amount of clotting was subjectively graded on a three-point scale as follows: grade 1, no or minimal clotting in one or more calyces or in the infundibula alone; grade 2, clotting in less than half of the renal pelvis; and grade 3, clotting in most of the renal pelvis and/or the ureter. If the stent was functional—shown by streaming of contrast material into the bladder—and renal clotting was graded 1 or 2, the floppy-tipped 0.035-inch guide wire was reintroduced, and the catheter was removed over the wire. If there was no substantial bleeding around the wire exit site during the next 5 minutes, the wire was also removed. A simple dressing was placed over the puncture site. Patients in this group were considered to have undergone technically successful one-stage or tubeless antegrade ureteral stent placement (group 1).

If one-stage stent placement failed—for example, because there was an impassable stricture, a stent was nonfunctional or there was bleeding, or grade 3 clotting was seen—an 8-F locking pigtail nephrostomy drainage catheter (Soft Drain; Angiomed, Karlsruhe, Germany) was inserted and left in place for free drainage. These patients, as well as those who were excluded from this study, underwent traditional two-stage stent placement after a few days (average, 2 days; range, 1–5 days) when the urine draining through the nephrostomy tube was clear; they were categorized as group 2.

Postprocedural Care

All patients underwent close hemodynamic and puncture site monitoring for 4 hours, in either the ward or the department. Patients were monitored in the department until the ward staff arrived to escort the patient back to the floor. The cases of patients who were monitored in the ward were reviewed the next day by the senior author and on further days as necessary by the referring clinicians.

Outpatient Care

Patients who had no complicating comorbid factors (eg, poor mobility or cardiac or respiratory disease) and who also fulfilled the inclusion and exclusion criteria as listed previously were selected for outpatient care. Those treated as outpatients were discharged from the interventional suite observation area after a 4-hour stay when they recovered from sedation, were pain free, were passing urine without difficulty or without substantial hematuria, and had stable blood pressure and pulse recordings. They were advised to maintain an oral fluid intake of at least 1 L for the next few days and to contact the hospital radiology or urology service if they developed severe pain, fever, or bleeding around the tube. All patients were informed that the bladder urine would be pink for a few days but to contact the hospital if bleeding increased or there were clots in the urine; all patients were contacted for a telephone interview on the next day (by the senior author or department nursing staff) and on further days as required.

Complications and Definition of Success

Success and complications in both groups were documented by means of retrospective review of case notes by the authors (U.P., M.Z.A.) and by means of communication with patients and referring clinicians. Technical success was defined as insertion of an antegrade stent, and successful clinical outcome was identified by increased urine output and improved renal function—as assessed by a decrease in serum creatinine level—without major complications.

The scoring system of the Society of Cardiovascular and Interventional Radiology (13) was used to grade the complications: Minor complications were those that required no therapy, observation alone, or nominal therapy and had no clinical consequence; major complications required specific therapy, unplanned increase in the level of care, further hospital stay—more than just an overnight stay—with or without permanent sequelae or death. Thus, septicemia requiring extra antibiotics and/or reinsertion of a nephrostomy tube or bleeding that required transfusion or embolization would all be major complications. Hematuria that lasted more than 24 hours was categorized as mild, moderate, or severe. Mild hematuria was defined as a pink tinge to the urine; moderate, as heavier bleeding; and severe, as that which required bladder catheterization or washouts.

Statistical Analysis

The major complication rates of the two groups were compared by using the Fisher exact test. Intergroup comparison of minor complication rates—specifically the grade of hematuria—was not possible, because we did not have sufficient historical data for the patients in group 2.

RESULTS

During the study period, antegrade ureteral stents were inserted in 97 patients, and 41 of these patients were suitable for attempted one-stage antegrade stent placement according to the study criteria. Thirty of the suitable 41 patients were men (age range, 26–76 years) and 11 were women (age range, 31–65 years). Thirty-two patients were referred as inpatients, and nine were outpatients; the causes of ureteral obstruction are listed in Table 1. Eleven patients underwent bilateral ureteral stent insertion. The main reasons for exclusion were suspected pyonephrosis, emergency cases, or both.

Success and Complications

In group 1, the procedure was technically successful in 36 (88%) of 41 patients, and stent placement was performed as a one-stage procedure (Figs 1, 2). A total of 45 stents were inserted: 27 patients underwent unilateral stent insertion; nine, bilateral stent insertion. There was no case of brisk bleeding; in all 36 cases, the stents were seen to drain at contrast material injection. In all cases, the stent functioned well, with reduction in serum creatinine level. The major complication rate was 6% (two of 36), and the clinical success rate was 83% (34 of 41). In comparison, in group 2 (which included five patients from group 1 in whom the procedure was unsuccessful plus the 56 excluded patients), the technical success rate was 100%, but the clinical success rate was 98% because one (2%) of the 61 patients had a major complication (septicemia). The difference in major complication rates between the two groups was not statistically significant ($P = .55$, Fisher exact test), but the numbers were small.

Two of 36 patients had a major complication after one-stage stent placement. One of these patients became septic after bilateral stent insertion and required further intravenous and oral administration of antibiotics; the hospital stay was extended 2 more days because of this complication. This patient was diabetic and had developed bilateral vesicoureteral junction obstruction after transurethral resection of the prostate gland. The cause of obstruction was thought to be surgical trauma complicated by bladder wall hypertrophy. The stents functioned well and were successfully removed after 6 weeks.

The second patient, with locally invasive prostate cancer, underwent bilateral one-stage stent placement 12 hours after unsuccessful cystoscopic stent exchange. Septicemia ensued after 7 days of apparently satisfactory stent function. Bilateral nephrostomy tubes were inserted, and both drained pus. After 4 days of external drainage, repeat nephrostograms revealed satisfactory stent drainage, and the nephrostomy tubes were removed. The stents functioned well, and there was no recurrence of infection. Since the sepsis developed so soon after the primary stent placement, it was classified as a procedure-related complication. This patient required at least 6 extra days of hospital stay, with intravenous administration of antibiotics and four further procedures: Two nephrostomy tubes were inserted and two nephrostograms were obtained as a result of this complication.

Minor Complications

On a nephrostogram obtained immediately after the procedure, 50% of patients had grade 2 clotting (filling less than half the renal pelvis), but this did not interfere with stent function. Regarding hematuria, in 14 patients it lasted longer than 24 hours, but there were no cases of severe hematuria that required bladder catheterization or washout. In all cases, the hematuria settled, and no patient required blood transfusion. As explained previously, statistical comparison with group 2 was not possible, because we did not have sufficient historical data on these aspects.

Reasons for Technical Failure of One-Stage Antegrade Stent Placement

In five patients, stents could not be placed with a one-stage procedure. In one outpatient (of the five) with bilateral ureteral obstruction, the procedure could not be completed because of pain, despite appropriate conscious sedation. The patient was discharged with bilateral nephrostomy tubes for free drainage; he returned 4 days later for successful secondary stent placement as an outpatient. In a further three patients (three ureters), the strictures were tight and could not be passed. All were inpatients and were treated with external drainage. Later, successful stent placement was performed through the antegrade route in all except one patient. That patient required a combined antegrade and retrograde procedure, as the stricture was very tight. For that procedure, the hydrophilic wire that was introduced antegradely was snared within the bladder with fluoroscopic guidance and was retrieved through the urethra, and a stent was forced antegradely over the tautly strained wire. In the final unsuccessful case, the patient had substantial clotting (grade 3) that was observed on the nephrostogram obtained after stent placement, and a nephrostomy tube was left in situ for 2 days before removal to prevent acute stent blockage (Fig 3).

Further Analysis of Outpatients

Of the outpatients, eight of nine underwent successful stent placement as a one-stage procedure, and the patient in whom stent placement was unsuccessful was described previously. As a group, the outpatients were younger (mean age, 37 vs 56 years), had better general health, and were more likely to have benign disease (Table 1).

TABLE 1
Causes of Ureteral Obstruction in 41 Patients

Cause	No. of Patients*
Benign	
Stone	3 (2)
Stricture after surgery	3 (2)
Pelviureteric junction obstruction	2 (1)
Malignant	
Bladder tumor	9 (1)
Prostate cancer	12 (2)
Cervical cancer	4 (1)
Ovarian cancer	5 (0)
Colonic tumor	1 (0)
Lymphoma	2 (0)

* Numbers in parentheses are numbers of outpatients.

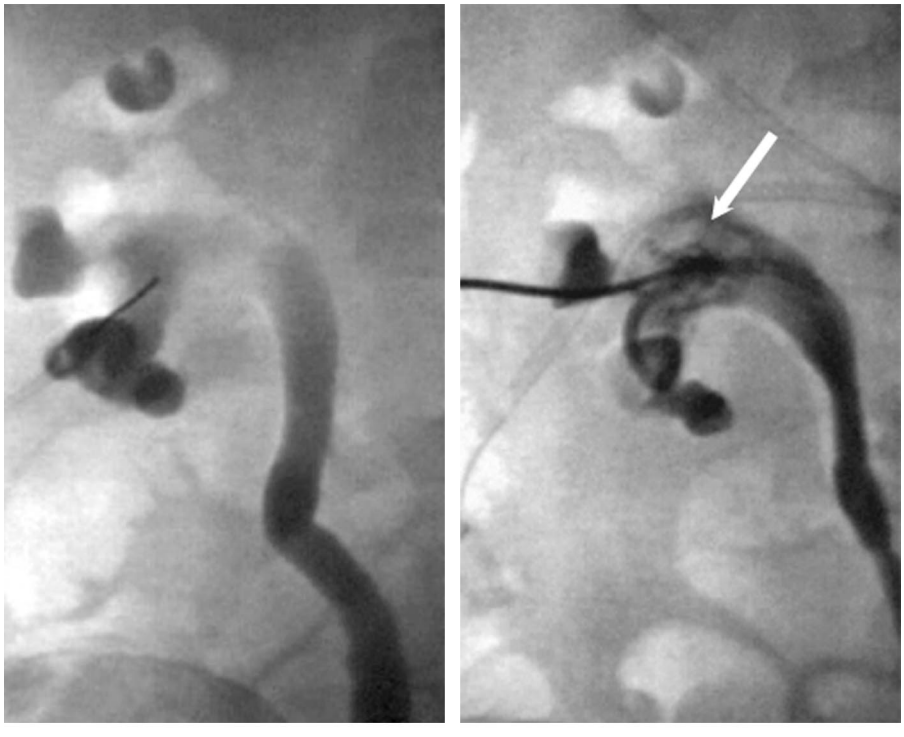
DISCUSSION

Ureteral stent placement is a routine safe procedure for the maintenance of ureteral patency. A stent can be inserted through either the antegrade or retrograde route through a cystoscope. Antegrade insertion is successful in 88%–96% of cases (8,9,10,12), but the two routes have not been critically compared in an unselected randomized fashion. Although the retrograde route is usually the preferred first option because the potentially serious complications related to renal puncture may be prevented, the final choice often depends on local skills and equipment. However, in some patients, antegrade stent insertion is more likely to succeed, particularly if the ureteral orifices are poorly visualized—for example, in patients with pelvic, bladder, or prostate malignancy. In one study, retrograde stent insertion failed in 14% of all cases, but the failure rate was higher in those with malignant or external obstruction than in those with benign obstruction—27% versus 6%, respectively (14). In our institution, there is a policy of first attempting antegrade stent placement in all patients with malignant obstruction, whereas patients with benign obstruction, in particular pelviureteric junction obstruction, undergo retrograde stent placement.

Whichever route is chosen, plastic pigtail stents are generally inserted. Whichever material or model is used, these stents have a limited life span and require

a. b.

Figure 1. Satisfactory one-stage tubeless antegrade stent insertion. **(a)** Frontal double-contrast nephrostogram. Posterior-facing calyx, chosen for stent insertion, is gas filled. **(b)** Appearance after stent (arrow) insertion, with no clotting in the system. Further views (not shown) confirmed stent function, and all access was removed.



a. b.

Figure 2. **(a, b)** Frontal images show satisfactory one-stage tubeless procedure, with grade 1 (small amount) clotting (arrow) after stent insertion. All access was removed, and clinical outcome was satisfactory.

regular replacement every 3–6 months (15,16). Metal stents may also be used, but many interventionalists use them selectively, as biocompatibility is still a problem (17). Experimentally and clinically, metal stents have a limited patency and invariably induce florid urothelial hyperplasia (18), although a recently introduced nickel-titanium alloy shape-memory stent appears more promising in this respect (19).

The major disadvantages of antegrade ureteral stent insertion are that it requires percutaneous renal puncture and traditionally was a two-stage procedure. With improvements in guide wires and stent design, stent placement in obstructed but noninfected ureters can be performed safely as a single procedure and is becoming the preferred option of many interventional radiologists. The clinical value of this so-called primary antegrade ureteral stent procedure (ie, renal access and stent insertion carried out as a single procedure) has been demonstrated in a separate group of patients (11), and it was successful in 80% of selected cases with a 2.5% major complication rate. However, even this modification required an overnight or approximately a 12-hour hospital stay, as a drainage nephrostomy tube was left in situ, and so patients still visited the radiology department a second time for tube removal.

In the present study, we have shown that primary ureteral stent insertion can be further refined such that true one-stage or tubeless stent placement can be performed in selected patients, including outpatients. The procedure was technically successful in 36 (88%) of 41 patients and clinically successful in 34 (83%) of 41 patients. The major complication rate was 6%, in spite of exclusion of all patients who were suspected of having pyonephrosis. The complication rate was higher than that in the group of patients who underwent two-stage stent placement in the present study (2%) and also higher than that from our previous experience with two-stage stent placement, where we found a major complication rate of 4% (six of 151 cases) in another published study (12). This difference was not statistically significant, but the numbers may have been too small to detect a significant difference (type II error). Thus, there remains the possibility that one-stage stent placement may be associated with a higher complication rate, but we think that with even more rigid suitability criteria, complications could be further reduced.

The major complication was septicemia, and both patients in whom this complication occurred had received gentamicin alone intravenously as a single infusion before the procedure. Some consider gentamicin alone to be inadequate (20), and we are discussing a new policy

regarding antibiotics with our hospital microbiology and infection control department. There were further predisposing factors in both cases—the first patient had undergone bladder surgery recently, and the second patient had undergone unsuccessful retrograde ureteral instrumentation. An indwelling bladder catheter was in place in both cases. From this experience, we have extended the exclusion criteria to all postoperative and postinstrumentation cases, as well as all cases in which there is a clinical suspicion of infection. On this basis, we would have excluded four of 41 patients in the current study.

Apart from sepsis, another major risk after percutaneous renal intervention is bleeding. No patient in the present study developed major bleeding, and we have not yet seen major bleeding that required embolization after ureteral stent placement in our practice, although one patient who was not part of this study required transfusion. In a standards-of-practice document from the Society of Cardiovascular and Interventional Radiology, a serious hemorrhage risk of 1%–4% is noted, although this risk refers to nephrostomy tube insertion alone (13). Before the start of this study, bleeding was our particular concern, as a freshly created 8–9-F renal puncture was to be left without a catheter to tamponade the track. However, we were persuaded that tubeless percutaneous urologic procedures were safe because of the encouraging experience after so-called tubeless percutaneous nephrolithotomy. It has long been clear that the large nephrostomy catheter—typically 24 F—left as a drainage catheter after even uncomplicated percutaneous nephrolithotomy results in marked minor postprocedure morbidity, which is related to discomfort and pain caused by the tube. To improve procedural morbidity, interest has focused on elimination of the postoperative nephrostomy tube if the procedure is uncomplicated (4).

Bellman and co-workers (5) have published the largest study about experience with this technique, to our knowledge. In their initial study, they had no major complications or an increased transfusion rate in 50 patients. Limb and Bellman (6) recently reported 112 patients (which includes the initial 50 from the previous study [5]). Eighty-six of these patients underwent stone extraction, and 26 patients underwent antegrade endopyelotomy through a 34-F sheath. All patients underwent antegrade ureteral stent insertion, and no external tube was left in place at the end of the operation if the patient was stone free and there was minimal bleeding around the wire after removal of the sheath. Six of 112 patients required postoperative transfusion. These transfusion numbers are not excessive for the number of patients in this group (reported rate, 12%–14% [13]); however, three patients were readmitted with late hemorrhage, and two of the three underwent renal embolization. Selection criteria were rigorous, and only 28% of the patients had cases suitable for tubeless percutaneous nephrolithotomy. The late hemorrhage and embolization rate is of concern; however, in another albeit smaller series, the researchers did not find any cases that required embolization (7). We have also increasingly followed this policy regarding tubeless procedures for treatment of renal stones in our own practice and have not seen any major bleeding that required embolization or surgical exploration.

Findings of the current study show that the smaller 8–9-F track of nephrostomy tube and stent insertion is also capable of self-sealing if antegrade drainage is unimpeded and there is no bleeding around the wire. However, these results are closely dependent on atraumatic renal entry by following the relatively avascular Brödel line as the plane of entry (21) and by puncturing the fornix or papillary tip to avoid injury to the segmental and arcuate arterial divisions or a major vein. Satisfactory sealing against vascular or urine leakage may not be ensured with infundibular or direct pelvic entry, with the associated risks of laceration of a large vessel or lack of surrounding renal parenchyma, respectively.

However, some bleeding is unavoidable during catheter exchange, as shown by the number of patients with clotting on nephrostograms obtained after stent placement and the number of those with mild or moderate hematuria (Table 2). This does not necessarily mean that temporary nephrostomy drainage is mandatory. Patients with clotting graded 1 or 2 had a satisfactory outcome as long as the stent was functional. However, those with a large amount of clotting should probably have a covering nephrostomy tube, as there is a greater possibility of acute stent obstruction.

There are also cost advantages to a one-stage procedure. Bed usage is improved, and the procedure is reduced to a single radiologic event. Can one-stop stent placement be extended to a purely outpatient procedure, with further cost improvements? Increasingly, many interventional radiologic procedures are performed in outpatients; these procedures include arterial, venous, and graft angioplasty; hemodialysis graft thrombolysis; and central venous access. However, there are few studies about the feasibility and safety of outpatient percutaneous uroradiologic procedures.

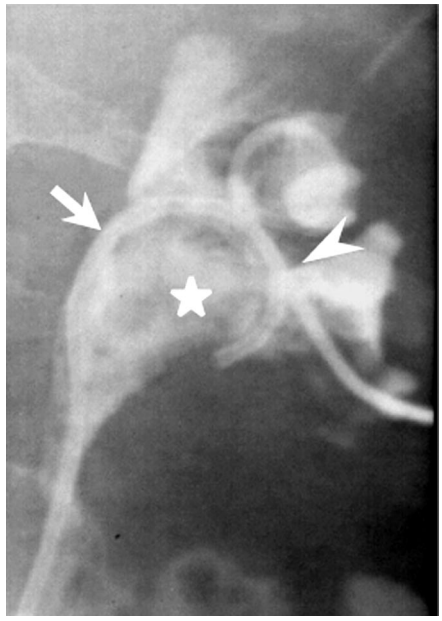


Figure 3. Postprocedural frontal nephrostogram shows grade 3 (substantial) clotting (★) in collecting system. Stent (arrow) was draining satisfactorily, but nephrostomy tube (arrowhead) was inserted for 2 days to guard against stent obstruction from a large volume of clotting.

Outpatient nephrostomy tube placement was first reported by Cochran et al (1) in 1991, but the results were poor, with development of sepsis in 21% of patients. Case selection was believed to be faulty, and in the authors' opinion, nephrostomy tube placement should "still be considered . . . an inpatient procedure." In contrast, findings of two other studies have been more encouraging. Gray et al (2) studied a group of 48 patients selected from 589 patients who were recruited during a 6-year period and reported successful outpatient nephrostomy tube insertion in 88% of all cases. Improved results were thought to reflect better case selection, but three of 48 patients required hospitalization: One had sepsis, one had major bleeding, and one elderly patient was unable to manage the nephrostomy tube. The inclusion criteria were strict—those with severe hypertension, untreated urinary tract infection, large staghorn calculi, and coagulopathy were excluded, and prophylactic antibi-

TABLE 2
Findings, Complications, and Success Rates

Finding, Complication, and Success Rate	Group 1, One-Stage Stent Placement*
Nephrostographic finding†	
Grade 1 clotting	18 (50)
Grade 2 clotting	18 (50)
Grade 3 clotting	0
Postprocedural complication	
Minor, hematuria‡	
Nil	15 (42)
Mild	12 (33)
Moderate	2 (6)
Severe	0
Major, sepsis	2 (6)
Success rate (n = 41) (%)	
Technical	88
Clinical	83

Note.—Group 2 (two-stage stent placement) included 56 patients who were excluded from one-stage stent placement and five patients in whom one-stage stent placement failed. Sufficient historical data were not available about nephrostographic findings and hematuria for group 2. Sepsis occurred in one (2%) patient, technical success rate was 100%, and clinical success rate was 98%.

* Except where otherwise indicated, data are numbers, and data in parentheses are percentages. Except where otherwise indicated, percentages were calculated with n = 36.

† Clotting was graded as follows: grade 1, no or minimal clotting in one or more calyces or in the infundibula alone; grade 2, clotting in less than half of the renal pelvis; and grade 3, clotting in most of the renal pelvis and/or the ureter.

‡ Hematuria (bladder urine) that lasted more than 24 h was graded as follows: nil, no bleeding; mild, pink tinge to urine; moderate, heavier bleeding; severe, bleeding that required bladder catheterization or washout. Details were not available in seven patients.

otics were not used. Successful results were also seen in a group of children and adolescents (3), with no immediate complication that required hospitalization. Late hospitalization was necessary in two of 39 patients, but in neither patient was the hospitalization believed to be related to the nephrostomy tube insertion, and it occurred more than 1 month later. Good results were again probably a result of careful patient selection. Only 39 (42%) of 93 cases were suitable—those with infection, stones, or single kidneys were excluded—and preprocedural antibiotic administration was used routinely in this series. To summarize, outpatient nephrostomy tube placement may be successfully performed, but in only a minority of all patients is it suitable. Patients should be carefully selected, and those who are suspected of having an infection or have a risk factor for it (eg, staghorn calculi) should be excluded. Even then, prophylactic antibiotics should be administered, and a careful nephrostomy tube placement technique should be followed.

To our knowledge, there has been no formal study of the safety and effectiveness of outpatient antegrade stent placement, but McFarlane et al (22) demonstrated the safety of retrograde ureteral stent placement (through a flexible ureteroscope) on an outpatient basis. Only a minority of patients in our study group were outpatients (nine of 41), and all were selected from a low-risk category. So far, our experience in this group is encouraging, but as with outpatient nephrostomy tube insertion, careful patient selection and prophylactic antibiotic administration are both important.

The limitations of our study should be recognized. First, data collection was retrospective and was performed by means of review of case notes. Second, many cases were excluded, and one operator performed the procedures in the selected patients; this may have caused an overestimation of the success rate. Most important, the numbers of patients included in the study were modest, particularly in the outpatient group, and we may have underestimated the complication rate. Further experience with one-stage antegrade stent placement and experience of other investigators is required.

To summarize, one-stage tubeless antegrade ureteral stent placement is feasible in carefully selected patients and will be successful in more than 80% of all patients, including outpatients. It is now our policy to attempt one-stage stent placement in all suitable cases. Until there is further experience, this technique should be reserved for stable and otherwise fit patients with normal results of hematologic studies. In our study, major complications were all infections. Patients who are clinically suspected of having infection should be excluded, as should those with a predisposition to infection (eg, history of recent retrograde ureteral instrumentation, failed retrograde stent insertion, or genitourinary tract surgery). We continue to be conservative in our approach to clinically unstable patients or those who are suspected of having infected systems. In our view, these patients should still undergo secondary antegrade stent placement after initial nephrostomy tube drainage has resolved the pyonephrosis and the clinical status improves. In any case, careful technique is very important, and all patients should receive preliminary antibiotic therapy. If a patient is suspected of having any periprocedural bleeding or substantial clotting is seen in the collecting system on a postprocedural nephrostogram, then a temporary nephrostomy catheter should be inserted. Even if one-stage stent placement has been successful, cases should be reviewed daily for the next few days either in the ward or by means of a telephone interview if the person is an outpatient.

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